ZOOLOGY

Project title: Climate Effects on Small Mammals: A Multi-Scale Approach to the Study of Mammalian Response to Global Climate Change

Principal investigator: Ms. Kim O'Keefe
Phone: 650-498-4995
Email: kokeefe@stanford.edu
Address: Department of Biological Sciences
Stanford University
371 Serra Mall
Gilbert Building
Stanford, CA 94305

Additional investigators: Kathleen Brizgys, Michael Milne

Objective: Our ability to predict the effects of global warming on biotic communities ultimately depends on our understanding of how individual species track specific climate variable at multiple scales. The purpose of this study is to gain insight into biotic response to climate change by characterizing the effects of climate on ground squirrel distribution, body size and population dynamics. Specifically, I hypothesize that temperature limits the distribution of *Spermophilus armatus*. To test this I will examine both present and historical patterns of distribution. First, I will use GIS data in conjunction with digitized locality data to perform statistical correlation analyses to determine if temperature correlates with the present distributional boundaries of the species. Second, to determine if there has been local extirpation and/or species replacement in response to the climate fluctuation of the late Holocene, I will perform phylogenetic analyses of ancient DNA sequences from specimens excavated from Lamar cave, a paleontological site in Yellowstone National Park. I also hypothesize that the effects of temperature will affect ground squirrel biology at the population level. I predict that in addition to range shifts, one of the ways in which ground squirrels respond to changes in temperature is by proximate and local changes in body size. I will test this in two ways. First I will examine the population level, phenotypic response of *S. armatus* to changes in the regional climate during the late Holocene by tracking changes in the body size of specimens from Lamar Cave. I will also study the distribution of body size along an elevational gradient. Changes in body size have direct and predictable effects on life history characteristics and thus on population dynamics. In order to gain insight into the mechanistic processes that explain these broader patterns of response I will develop and test a model that examines how the energetics of the individual are effected by the local thermal environment. Ground squirrel of the genus *Spermophilus* are particularly useful for studying biotic response to climate change because they are obligate hibernators and they show sensitivity to environment cues such as temperature. In addition, ground squirrels do not migrate therefore changes in abundance, distribution or the timing of life history events reflect response to local climate phenomena. Ground squirrels are also a vital link in terrestrial trophic interactions. As such, changes in ground squirrel abundance and distribution are likely to affect other species that prey on them. Thus ground squirrels may prove to be a useful indicator species

for tracking the effects of current climate change at the local level and for predicting the effects of climate change on the community.

Findings: As part of an effort to better understand how microclimate effects the body size and population density of ground squirrels we trapped, measured and marked individual ground squirrels from four sites along an elevational (and thus temperature) gradient. Our field research in Yellowstone National Park was conducted from July 1 to July 31, 2001. Three of our sites were within the boundaries of the park. At each site (worked sequentially) we set up a trapping grid of 150 ft x 245 ft and laid out 21 tomahawk live-traps. Each captured animal was given a unique ear tag number and dye mark on their pelage. The dye mark allowed us to determine whether we'd caught a particular animal using binoculars and thus determine how well we'd trapped the colony from afar. In addition, it allowed us to determine and record a recapture without having to re-handle the animal to examine its ear-tag number. Sex, estimated age and standard body size measurements including: body mass, total length, tail length, hind foot, ear from notch and zygomatic width were taken for each animal captured. In addition we visually mapped the positions of each burrow entrance on the grid to determine the burrow-density (BD) and better understand how well BD represents the total density of animals.

The following is a summary of our summer research with a brief description of our preliminary findings. Site one (Gardiner) is located about 0.5 miles up the old Gardiner Highway from the North Entrance gate. We caught and released 18 animals in 525 trapping hours. Site 2 (Lamar) is located about four miles south of the Slough Creek Campground on the northwest side of the Lamar River. We worked there from July 17–July 22. We trapped for a total of 211 trapping hours and captured and released 20 individuals. Site three (Lamar South) is located just across the Lamar River from Site 2 and it is approximately one mile north of the northeast entrance road. We worked there from July 23–July 25 and we trapped for a total of 173 trapping hours. We caught and released 23 individuals. Site four is outside of the park in the Shoshone National Forest. We caught 13 individuals in 320 trapping hours.

To compare the morphologic measurements between the sites I first separated the data by sex and age. I then performed a series of One-Way ANOVAs to test for significant differences in body size between the sites. Preliminary analysis of the morphologic data indicates that there is significant difference in the average body size of ground squirrels between the four sites with the largest animals occurring in the highest elevations (as predicted by Bergman's rule). Burrow density varies dramatically between sites but does not correlate with the number of individuals caught at each site. However I was unable to do a total count of all individuals at each site this season.

This report summarizes what I have found from the first of three planned field seasons. I will need to return this coming season to repeat the measurements and counts at each site. This time I hope to arrive just as the ground squirrels emerge from hibernation and then again as they immerge.